

**413.04. CONSTRUCTION METHODS.**

- (a) **Asphalt Concrete Shoulders Or Mainline Pavement.** When forming or machine cutting (routing) in asphalt, produce indentations in accordance with the details shown in the Plans or the Standard Drawing(s). Position the roller by using planking or by other approved means so that the asphalt concrete is indented only at those locations specified on the project plans. Form the rumble strips in one or more repeating passes of the roller while it is in the vibratory mode and the asphalt concrete is hot.
- (b) **Portland Cement Concrete Shoulders Or Mainline Pavement.** When forming rumble strips by any method—hand forming, blockouts for precast blocks, or machine cutting (routing)—produce strips meeting all detail requirements for spacing, length, depth, and rumble section as shown in the Plans or on the Standard Drawing(s).

**413.05. METHOD OF MEASUREMENT.**

Rumble strips of the various classifications shall be measured as follows:

- **Method AC-CON:** *Asphalt concrete continuous* will be measured by the linear foot (meter) along the longitudinal centerline or lane baseline rounded to the nearest foot ( meter).
- **Method AC-CYC:** *Asphalt concrete cyclical* will be measured by each group of recurring grooves, as shown on the plans. Only those groups meeting dimensional tolerances as shown on the plans will be measured for payment.
- **Method PCC-CYC:** *Portland cement concrete cyclical* will be measured by each group of recurring grooves, as shown on the plans. Only those groups meeting dimensional tolerances as shown on the plans will be measured for payment.

**413.06. BASIS OF PAYMENT.**

Accepted quantities of shoulder or mainline pavement rumble strips shall be paid for at the contract unit price as follows:

(A) RUMBLE STRIP-METHOD AC-CON.....	LINEAR FOOT (METER)
(B) RUMBLE STRIP-METHOD AC-CYC(GROUP).....	EACH
(C) RUMBLE STRIP-METHOD PCC-CYC(GROUP).....	EACH

Such payment amount shall be full compensation for furnishing all equipment, labor, and incidentals necessary to complete the production of mainline pavement or shoulder rumble strips (grooves) as shown in the plans or on the Standard Drawing(s).

## **SECTION 414**

### **PORTLAND CEMENT CONCRETE PAVEMENT**

**414.01. DESCRIPTION.**

This work shall consist of constructing a jointed pavement composed of portland cement concrete (P.C.C.), with or without reinforcement or continuously reinforced pavement, as specified, on a prepared base course in accordance with these Specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the Plans or established by the Engineer.

**414.02. MATERIALS.**

Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials:

Portland Cement Concrete	701
Fly Ash	702
Steel Reinforcement, Dowel Bars & Tie Bars	723

Tie bars which are bent and later straightened to facilitate construction shall conform to the following:

Deformed Billet-Steel Bars for Concrete Reinforcement	AASHTO M 31 Grade 300
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Approved reclaimed portland cement concrete materials may be used provided that the Department is notified in writing of the intention to use reclaimed materials, and provided that the requirements of Section 701 for portland cement concrete are met.

Furnish the Department with copies of the daily quality control tests.

**414.03. EQUIPMENT.**

Equipment and tools necessary for handling materials and performing all parts of the work shall be the responsibility of the Contractor as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations.

(a) **Plants and Equipment.**

- (1) **General.** The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation. All controls, gauges, revolution counters, etc. shall be properly functioning.

Provide documented evidence to the Department that the batching plant is producing quality concrete, and that the plant is functioning in proper working order at all times. See AASHTO M 157 Annex "Concrete Uniformity Requirements." The mixing plant shall conform to requirements of AASHTO M 157 as appropriate.

Clean the mixers at suitable intervals. Repair or replace the pickup and throw-over blades in the drum or drums when they are worn down 1/6 or more of the original width of blade. Either have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth, or provide permanent marks on blades to show points of wear 1/6 of the width from new conditions. The Department recommends drilled holes of 1/4 inch ( 6 mm) diameter near each end and at the midpoint of each blade.

Storage silos for cement and fly ash shall be properly vented during filling or use. If a pressurized air system is used for discharge of cement or fly ash, this system shall provide for moisture traps so as to reduce caking of materials during storage.

Plants and scales shall be inspected and certified as often as the Engineer may deem necessary to assure their accuracy, but not less than every six months.

(b) **Placing And Finishing Equipment.**

- (1) **Slip Form Paver.** The concrete shall be placed with an approved slipform paver designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine in such manner that a minimum of hand finish will be necessary to provide a dense and homogeneous pavement in conformance with the Plans and Specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibrations shall be accomplished with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete.

The rated frequency of the surface vibrators shall not be less than 3,500 impulses per minute and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators. When spud-type internal vibrators, either hand operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute. They shall not come into contact with the joint, load transfer devices, subgrade, or side forms.

The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

(2) **Stationary Side-Form Method.**

- 2.1 *The finishing machine* shall be equipped with at least two oscillating-type transverse screeds capable of finishing the surface to the tolerance specified.

Vibrators for full width consolidation of the concrete may be the surface pan type (limited to pavements no thicker than 8 inches (203 mm)) or the internal type with either immersed tube or multiple spuds. Vibrators may be attached to the spreader or the finishing machine, or mounted on a separate carriage, and shall not contact the joint, load transfer device, subgrade, or side forms. The rated frequencies shall be not less than 3,500 impulses per minute for surface vibrators, 5000 impulses per minute for tube vibrators, and 7000 impulses per minute for spud vibrators.

When spud-type internal vibrators are used next to the forms, the frequency shall not be less than 3,500 impulses per minute.

- 2.2 *Use forms and vibrating or rotary strike off screeds* to construct radii, inlet basins, gore areas, lane tapers, intersection quadrants, and other areas inaccessible to mainline paving machinery. Be careful to achieve thorough consolidation and uniformity of the product. Segregation and excessive grout buildup will not be accepted. The tolerances specified shall be met.

- (3) **Transverse Texturing Machine.** The transverse texturing machine shall be either a vibrating roller or a comb equipped with steel tines. The machine shall be self-propelled and shall automatically lift the roller or tine comb bar near the edge of the pavement to minimize edge damage. Hand texturing methods will be permitted in a manner accepted by the Engineer in those areas where the mechanical equipment cannot be used.

- (c) **Concrete Saw.** Provide sawing equipment in good working condition, adequate in number of units and power, to complete the sawing to the required dimensions and at the required rate. As back up, also provide at least one standby saw in good working order. In addition, maintain an

ample supply of saw blades at the site of the work at all times during sawing operations. Also provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.

- (d) **Forms.** Make straight side forms of a metal having a thickness of not less than 7/32 inch ( 5 mm), and furnish them in sections not less than 10 feet ( 3 m) in length. Forms shall have a depth at least equal to the prescribed thickness of the concrete and a base width that will provide adequate support for all equipment operating on the forms.

Use flexible or curved forms of proper radius for curves of 100 feet ( 30 m) radius or less. Provide flexible or curved forms with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment.

Flange braces shall extend outward on the base not less than 2/3 height of the form. Remove forms with battered top surfaces and bent, twisted, or broken forms from the work, and do not use repaired forms until they have been inspected and approved. The top face of the form shall not vary from a true plane more than 1/8 inch ( 3 mm) in 10 feet ( 3 m), and the upstanding leg shall not vary more than 1/4 inch ( 6 mm). Clean the forms of old accumulated concrete, grout, or other materials. Also, spray the forms or cover them with a form-release agent prior to their use.

- (e) **Header Boards.** When paving operations are stopped, use header boards of 2 inch ( 50 mm) material, cut to the exact cross section of the paving slab and set to a line parallel to the transverse joint. Design the boards so as to insure accurate installation of dowels or tie boards as called for on the Plans.

- (f) **Longitudinal Float.** The longitudinal float may either be a mechanical float or screed mechanism acceptable to the Engineer or a manually-operated float. The hand-operated float shall be a rigid straightedge float not less than 12 feet ( 3.6 m) nor more than 18 feet ( 5.4 m) in length, with a troweling or smoothing surface not less than 8 inches ( 200 mm) nor more than 12 inches ( 300 mm) in width, and shall be worked from bridges spanning the pavement.

Maintain longitudinal floats in good repair and working order at all times. In the event satisfactory results are not being obtained by use of a mechanical float, have a manually operated float available on the job for immediate use.

Adjust and operate the mechanical float so that the screed will have a small quantity of concrete in front of it at all times. Do not lower or raise the screed solely for the purpose of maintaining the proper amount of concrete in front of the screed.

In lieu of the mechanical or hand-operated longitudinal float, the use of a finishing machine with the float pan type finisher will be permitted provided that satisfactory performance and specified surface smoothness and tolerances are obtained.

- (g) **Small Tools, Belt, and Burlap Drag.** Furnish a sufficient number of work bridges, hand floats, 10 feet (3 m) straightedges, and small tools to satisfactorily complete the pavement as specified herein. Any float or straightedge which becomes warped or distorted and any belts or finishing tools which are defective shall be promptly replaced with acceptable appliances.

The burlap drag shall consist of a seamless strip of burlap or cotton fabric, which shall

produce a uniform surface of gritty texture after dragging it longitudinally along the full width of pavement. The dimensions of the drag shall be such that a strip of burlap or fabric at least 3 feet (1 m) wide is in contact with the full width of the pavement surface while the drag is used. The drag shall consist of not less than 2 layers of burlap with the bottom layer approximately 6 inches (150 mm) wider than the upper layer.

- (h) **Spraying Equipment.** The equipment for applying the white pigmented curing membrane shall be the fully atomizing type equipped with a tank agitator which will keep the compound thoroughly mixed during application. Hand sprayers of the pressure tank type accepted by the Engineer may be used to apply curing membrane to vertical surfaces, irregular areas, or edges after form removal.
- (i) **Joint Sealing Equipment.** Joint Sealing Equipment shall meet the requirements of Subsection 419.03.

#### 414.04. CONSTRUCTION METHODS.

- (a) **Preparation of Grade.** After the roadbed has been graded and compacted, trim the grade approximately to correct elevation, extending the work at least 2 feet (0.6 m) beyond each edge of the proposed concrete pavement. When the foundation is stabilized with an admixture, it shall be within the tolerances provided for the foundation type.

Check and correct the alignment and grade elevations of the forms immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, reset and recheck the form.

- (b) **Conditioning of Subgrade or Base Course.** The subgrade or base course shall be brought to proper cross section.

When cementitious bases are used, remove material trimmed from high areas and low areas and fill them with concrete integral with the pavement. Maintain the finished grade in a smooth and compacted condition until the pavement is placed.

Unless waterproof subgrade or base course cover material is specified, make sure the subgrade or base course is uniformly moist when the concrete is placed.

- (c) **Handling, Measuring, and Batching Materials.** The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of material to the work. Deliver both fine and coarse aggregate to the plant far enough in advance to allow time for proper sampling and testing. The quantities of materials available at the concrete plant at no time shall be less than that required for a normal day's paving operation. Delivering and stockpiling materials shall be in accordance with Subsection 106.09.

Measure and batch materials for concrete in accordance with AASHTO M 157, except as otherwise specified. Weigh the fine aggregate and each size of coarse aggregate separately in hoppers, in the respective amounts set by the approved job mix. Measure cement by weight, using separate scales and hoppers with a device to indicate positively the complete discharge of the batch of cement into the batch box or container.

- (d) **Mixing Concrete.** Mix and deliver concrete in accordance with AASHTO M 157 except as otherwise specified. The concrete may be mixed at the site of the work, in a central-mix plant, or in truck mixers. The mixer shall be of an approved type and capacity. Measure mixing time from the time all materials, except water, are in the drum. There shall be a maximum time limit of one hour from the time that the water, cement, and aggregate are combined until the mixed concrete is deposited in its final position.

When mixed at the work site or in a central mixing plant, the mixing time shall not be less than 50 seconds nor more than 90 seconds. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. Remove the contents of an individual mixer drum before a succeeding batch is emptied therein.

Operate the mixer at a drum speed as shown on the manufacturer's name plate.

*NOTE: Any concrete mixed less than the specified time shall be discarded and disposed of at the Contractor's expense.*

The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic yards ( cubic meters), as shown on the manufacturer's standard rating plate on the mixer; however, an overload up to 10 percent above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform, and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

Retempering concrete by adding water or by other means will not be permitted, except in the following circumstances:

When concrete is delivered in transit mixers or agitators, additional water may be added to the batch materials, and additional mixing performed at 20 revolutions at mixing speed, provided the design maximum water-cement ratio is not exceeded.

- (e) **Limitations of Mixing.** No concretes shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 50° ( 10°C) and not more than 90°(32°C) at the time of placement.

When concreting is authorized during cold weather, heat the aggregates by either steam or dry heat prior to placing them in the mixer. The apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the materials. During concrete mixing, delivery, and placement in hot weather, use proper practices and procedures to insure that the maximum temperature of the concrete is not exceeded, pending acceptance by the Engineer. The Contractor shall be responsible for the protection and quality of concrete placed during any weather conditions.

- (f) **Setting Forms.** When formed paving equipment is used, set forms to line and grade by shimming or other approved methods. Correct imperfections or variations in the base or foundation which prohibit the placement of forms to the specified lines or grades in a manner accepted by the Engineer. Stake forms into place with not less than three pins for each 10 feet (3 m) section. Place a pin at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not deviate from true line by more than 1/4 inch (6 mm) at any point. No excessive settlement or springing of forms under the finishing machine will be tolerated. Clean and oil forms prior to the placing of concrete.

- (g) **Placing Concrete.** Placing of concrete will not be allowed when there is frost in the foundation course.

Deposit the concrete on the grade in such a manner as to require as little rehandling as possible. Unless truck mixers, truck agitators, or nonagitator hauling equipment are equipped with means for discharge of concrete without segregation of the materials, unload the concrete into an approved spreading device and mechanically spread it on the grade in such manner as to prevent segregation of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Do any necessary hand spreading with shovels. Workers shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

Where concrete is to be placed adjoining a previously constructed lane of pavement—and mechanical equipment will be operated upon the existing lane—it shall have attained the strength specified for opening to traffic in Subsection 414.04(q). If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after three days.

Operate the slip-form paver with a continuous forward movement, and coordinate all operations of mixing, delivering, and spreading concrete to provide a uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, immediately stop the vibratory and tamping elements also.

Thoroughly consolidate concrete against the supporting grade and against the face of all forms and joint assemblies throughout their full length. Do not operate the vibrator in any one location longer than necessary to complete the consolidation.

Deposit concrete as near to expansion and contraction joints as possible without disturbing them, but do not dump it from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

Should any concrete materials fall on or be worked into the surface of a completed slab, remove them immediately by approved methods.

Do not place concrete unless an inspector is present.

- (h) **Test Specimens.** Furnish the concrete necessary for performing acceptance testing.
- (i) **Steel Reinforcement.** Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust which could impair bond of the steel with the concrete. Thin powdery rust and tight rust that does not reduce the effective cross section is not considered detrimental and need not be removed.

- (1) **Placement of Reinforcement for Continuously Reinforced Concrete Pavement.** Reinforcement may be installed by one of the following methods:

- Preset on chairs or high chair bars or
- Placed by mechanical means.

Regardless of the method of placement used, the horizontal spacing tolerances shall be within 1/2 inch ( 12 mm) of Plan dimensions for longitudinal steel and within 2 inches ( 50 mm) of Plan dimensions for transverse steel. These tolerances notwithstanding, the number of longitudinal members for a given width of pavement and the number of transverse members per station shall be that shown on the Plans.

The position of the longitudinal and transverse steel in the vertical direction shall be that shown on the Plans.

At the time concrete is placed, handle the reinforcement with such care that the bars will remain reasonably flat and free from distortions. Bars shall be free from such kinks or bends as may prevent them from being properly assembled or installed. If forms are used, oil them prior to placement of reinforcement.

- 1.1 *Reinforcement Preset on Chairs or High Chair Bars.* The reinforcement shall be supported on chairs or continuous high chairs meeting the requirements of the Specifications and the approval of the Engineer.

Make the chairs of high chair bars high enough to allow steel placement within dimensioned tolerances.

Arrange and space the chairs so that the reinforcement will be supported in proper position without permanent deflection or displacement occurring during placing and consolidation of concrete.

Provide sufficient bearing at their base to prevent overturning and penetration into the base.

Design so as not to impede the placing and consolidation of concrete.

Do not set high chair bars so close to other transverse members as to make placing concrete through the space difficult. This is particularly important in lapped areas where there is a concentration of reinforcement.

*NOTE: Welding of chairs to transverse bars will be permitted.*

If requested by the Engineer, submit a sample of the chair or high chair bar to be furnished. Show chairs and the layout in the plans. If the support system does not maintain the reinforcement in the position required by these Specifications during placing and finishing of the concrete, increase the number of chairs or take such other steps as may be required to assure proper final position of the steel.

When the reinforcement consists of loose bars fabricated on the grade, secure the longitudinal bars to the transverse bars by wire ties or clips at sufficient intersections to maintain the horizontal and vertical tolerances specified herein.

- 1.2 *Reinforcement Placed by Mechanical Means.* The method of placement used shall be capable of maintaining the approved lap pattern and controlling the length of the lap of



longitudinal steel so as to assure that the specified minimum lap dimension will be obtained.

Place the reinforcement at the proper depth in the concrete by means of a machine approved by the Engineer. Perform placement of the reinforcing steel in such a manner that the concrete, after final finishing, shall show no segregation attributable to the placing operation. Operate the machine in such a manner that it does not drag the reinforcement.

If the machine shows any tendency to displace the reinforcement, seek the approval of the Engineer to halt paving operations until the machine is properly adjusted or until another machine may be provided that will operate in a satisfactory manner. Alternatively, install the reinforcement in accordance with the provisions of Subsection 1.1 above.

Operate the machine in such a manner that the concrete will not be excessively vibrated or otherwise manipulated.

Longitudinal reinforcement may be fabricated on the grade and raised into position by use of rollers, tube sleds, or other devices capable of supporting the reinforcement in the specified vertical and horizontal position while the concrete is being placed and consolidated. Place transverse steel as shown on the plans.

- (2) **Lap Splices in Reinforcing Steel.** Lap the reinforcing bars used as continuous reinforcement in the longitudinal direction in a staggered pattern as shown on the Plans. Laps in the longitudinal reinforcement shall be tied, fastened with clips, or otherwise securely fastened regardless of the method of placement.

- (j) **Joints.** Construct joints perpendicular to the surface of the slab and of the type, dimensions, and at locations shown on the Plans. Use suitable guidelines or devices to assure satisfactory alignment of joints.

All sawed joints shall be reasonably straight and true to line; if any are not, repair or correct them to the satisfaction of the Engineer. Seal the sawed joints in accordance with Subsection 419.04.

- (1) **Longitudinal Joints.** Saw and seal longitudinal contraction joints. Do not saw and seal longitudinal construction joints. Place deformed steel tie bars of specified length, size, spacing, and material perpendicular to the longitudinal joint. Place tie bars, by approved mechanical equipment or rigidly secured by chairs or other approved supports, to prevent displacement. Do not paint or coat bars with asphalt or other materials or enclose them in tubes or sleeves.

Saw the longitudinal contraction joint as soon as possible to the depth shown on the Plans without causing damage to the pavement or joint. Thoroughly clean the sawed area, leaving it free from dust, chalk, and contaminants and fill it with an approved joint-sealing material.

Do not allow construction equipment and other vehicles which may cause damage to the pavement joints on the pavement before the end of the curing period.

When tested with a straightedge, the surface across any joint shall not vary from the straightedge by more than 1/8 inch (3 mm).

**(2) Transverse Joints.**

- 2.1 *Expansion or Isolation Joint.* Make the expansion joint filler continuous from form to form, shaping it to the base and to the keyway along the form. Furnish preformed joint filler in lengths equal to the pavement width or equal to the width of one lane.

*NOTE: Do not use damaged or repaired joint filler unless approved by the Engineer.*

Appropriately punch premolded joint filler to the exact diameter and location of any dowels. Unless otherwise provided, furnish it in lengths equal to the pavement width. However, in cases where pavement two or more traffic lanes wide is being placed, the premolded filler may be furnished in sections, provided the length of each section is equal to the width of one lane. Where more than one section is used in a joint, securely lace or clip the sections together. The bottom edge of the filler shall project to or slightly below the bottom of the slab; and unless otherwise prescribed, the top edge shall be 1 inch (25 mm) below the surface of the pavement. While the concrete is being placed, protect the top edge of the filler by a metal channel cap of at least 10 gauge material, having flanges not less than 1 1/2 inch (40 mm) in depth.

After the concrete has been placed on both sides of the joint and struck off, slowly and carefully withdraw the installing bar, leaving the premolded filler in place. Before the installing bar and channel cap are completely withdrawn, carefully vibrate the concrete and work additional freshly mixed concrete into any depression left by the removal of the installing bar. The filler must be exposed for the full width of the slab. Clean and reoil the installing bar prior to each installation of a joint. After the removal of the side forms, the ends of the transverse joints at the edges of the pavement shall be carefully opened for the entire depth of the slab. Before the pavement is opened to traffic, seal or top out premolded joints with the joint-sealing filler specified, leaving a neat uniform strip of joint-sealing filler slightly below the surface of the pavement.

For joints in concrete curbing that cannot be satisfactorily sawed, form them by means of steel templates or other approved joint-forming dividers installed at the time the concrete is poured and at the location of the joint to be sawed.

- 2.2 *Contraction Joints.* Form transverse contraction joints by sawing them as soon as possible to the depth shown on the Plans without causing damage to the pavement or joint. Saw succeeding joints consecutively from the beginning to the end of the day's run, and saw all transverse joints soon enough to prevent uncontrolled transverse cracking.

Maintain the sawed area to the following standards:

Thoroughly clean and dry it; keep it free from dust, chalk, contaminates, and spalling; and fill it with an approved joint sealing material.

Do not allow construction equipment and other vehicles which may cause damage to the pavement joints to drive on the pavement before the end of the curing period.

- 2.3 *Transverse Construction Joints For Jointed Pavement.* Unless otherwise directed, construct transverse construction joints when there is an interruption of more than 30 minutes or as field conditions dictate in the concreting operations. No transverse joint

shall be constructed within 10 feet (3 m) of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10 feet (3 m) long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed by the Engineer.

Provide a rigid header with holes or slots for dowel bars that shall be of the spacing and dimensions as for expansion joints. Submit any alternate methods for header construction to the Engineer for approval.

*NOTE: In no case shall the load transfer bar vary more than 3/8 inch (9 mm) from the planned horizontal or vertical position.*

- 2.4 *Transverse Construction Joints for Continuously Reinforced Concrete Pavement.* Install a transverse construction joint at the end of each day's work or whenever paving operations must be interrupted for more than 30 minutes. Form the joint by placing the concrete against a headerboard approved by the Engineer. The longitudinal reinforcing steel shall extend through the headerboard and be properly supported from the base beyond the headerboard to prevent undue deflections during paving operations.

Cover the reinforcement which extends beyond the headerboard with sheets of plywood or other material to permit workers to walk on the steel without displacing it and to prevent concrete spilling on the base during screeding operations.

Construct construction joints and lap splices as shown on the current Design Standard.

Provide additional consolidation to the pavement areas adjacent to both sides of transverse construction joints using hand vibrators inserted into the concrete, and refinish the surface. These areas shall extend at least 10 feet (3 m) from the joint. When tested with a 10 feet (3 m) straightedge, the surface across the joint shall not vary more than 1/8 inch (3 mm).

- (3) **Load Transfer Devices.** The placement method of load transfer devices is optional. Firmly hold or mechanically place approved load transfer devices in the position indicated on the Plans. In all cases, dowels shall be parallel to the surface and centerline of the slab and shall vary no more than 3/8 inch (9 mm) from the planned horizontal or vertical position. Cap dowels for expansion joints as shown on the plans.
- (k) **Final Strike off, Consolidation, and Finishing.**
- (1) **General.** The sequence of operations shall be as follows:
- Strike off and consolidation
  - Floating and removal of laitance
  - Straightedging
  - and Final surface finish

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

- (2) **Finishing at Joints.** The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated.
- (3) **Slip-form Paving.** The strike-off, consolidation, and initial finishing shall be performed by the slip-form paver. At the beginning of the day's run, straight-edge the construction joint and the initial slab both longitudinally and transversely until the machine produces a satisfactory slab within the tolerances specified in 401.04 (a).

*NOTE: For the outer 6 inches ( 150 mm) along the edge of the pavement, a maximum deviation of 1/4 inch ( 6 mm) from a 10 foot ( 3 m) straight-edge placed perpendicular to the centerline of the roadway will be permitted.*

Perform occasional additional straight-edging throughout the day's run to insure the machine continues to produce a satisfactory slab. When constructing auxiliary parallel lanes, there shall be no appreciable slump along the edges of adjoining lanes.

*NOTE: Any valleys or depressions that will not drain properly shall be corrected by the Contractor at his expense.*

It is the intent of this Specification that modern slip-form machinery in good working order be used; therefore, keep hand-finishing to a minimum, using it only to correct surface defects or irregularities.

**(4) Formed Paving.**

- 4.1 *Machine Finishing.* As soon as the concrete has been placed, strike it off and screed it with an approved finishing machine. The machine shall go over each area of pavement as many times and at such intervals as necessary to give the proper compaction and to leave a surface of uniform texture. Avoid excessive operation over a given area. Keep the tops of the forms clean with an effective device attached to the machine, and maintain the travel of the machine on the forms true without lift, wobbling, or other variation tending to affect the precision finish.

During the first pass of the finishing machine, maintain a uniform ridge of concrete ahead of the front screed for its entire length.

Vibrators for full width vibration of concrete paving slabs shall meet the requirements in Subsection 414.03(b).

*NOTE: If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and methods which will produce pavement conforming to the Specifications.*

- 4.2 *Hand Finishing.* Hand finishing methods will not be permitted except under the following two conditions:
  - (1) In the event of breakdown of the mechanical equipment, to finish the concrete already deposited on the grade or in transit when the breakdown occurs.
  - (2) With narrow widths or areas of irregular dimensions where operation of the mechanical equipment is impractical.

As soon as the concrete has been placed, strike it off and screed it. Use an approved portable screed. If reinforcement is used, provide a second screed for striking off the bottom layer of concrete.

The screed for the surface shall be at least 2 feet (0.6 m) longer than the maximum width of the slab to be struck off.

Attain consolidation by the use of a suitable vibrator or other approved equipment.

In operation, move the screed forward on the forms with a combined longitudinal and transverse shearing motion—moving always in the direction in which the work is progressing; manipulate it so that neither end is raised from the side forms during the striking off process. If necessary, repeat this until the surface is of uniform texture reasonably true to grade and cross section, and free from porous areas.

- 4.3 *Floating.* After the concrete has been struck off and consolidated, further smooth, true, and consolidate it by means of a longitudinal float.

If necessary, use long-handled floats having blades not less than 5 feet (1.5 m) in length and 6 inches (150 mm) in width to smooth and fill in open textured areas in the pavement. Do not use long-handled floats to float the entire surface of the pavement. Be careful not to work the crown out of the pavement during the operation. After floating, remove any excess water and laitance from the surface of the pavement by a straightedge 3 feet (3 m) or more in length. Lap successive drags one-half the length of the blade.

- 4.4 *Straightedge Testing and Surface Correction.* After the floating has been completed and the excess water removed, but while the concrete is still plastic, test the surface of the concrete for trueness with a 10 feet (3 m) straightedge. For this purpose, furnish and use an accurate 10 feet (3 m) straightedge. Hold the straightedge in contact with the surface in successive positions parallel to the road centerline, going over the whole area from one side of the slab to the other as necessary. Advance along the road in successive stages of not more than one-half the length of the straightedge. If any depressions are found, immediately fill them with freshly mixed concrete, strike them off, consolidate, and refinish. Cut down high areas and refinish. Pay special attention to assure that the surface across joints meets the requirements for smoothness. Continue straightedge testing and surface corrections until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross section.

**(5) Texturing.**

- 5.1 *Burlap Drag.* Use the burlap drag prior to final finish of the pavement surface. The burlap or cotton fabric drag shall produce a uniform surface of gritty texture after it has been dragged longitudinally along the full width of pavement. For pavement 16 feet (4.9 m) or more in width, mount the drag on a bridge which travels on the forms. Maintain the drag clean and free from encrusted mortar. When drags cannot be cleaned, discard them and replace them with new drags.

- 5.2 *Transverse Groove Final Finish.* When final longitudinal texturing with the burlap drag is completed, mechanically transverse groove and texture the plastic pavement surface of the driving lanes and ramps in a manner accepted by the Engineer, using equipment meeting the requirements of Subsection 414.03(b)3. You have the option of tining the shoulder surface.

The grooves shall be perpendicular to the centerline of the pavement, 1/16 to 1/8 inch (2 to 3 mm) wide, 1/8 to 1/4 inch (3 to 6 mm) deep, and approximately spaced at 1/2 to 1 inch (12 to 25 mm). The machine shall automatically lift the roller or tines near the edge of pavement so that edge damage shall be held to a minimum. The overlap between grooving passes shall be less than 3 inches (75 mm).

In those areas where mechanical grooving equipment cannot be operated, hand grooving methods will be permitted in a manner approved by the Engineer.

- 5.3 *Edging at Forms and Joints.* After the final finish, but before the concrete has taken its initial set, work the following with an approved tool and round them to the radius required by the Plans:

The edges of the pavement along each side of each slab; and each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to the radius required on the plans to produce a well-defined and continuous radius and obtain a smooth, dense mortar finish. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.

At all joints, eliminate any tool marks appearing on the slab adjacent to the joints by brooming the surface. In doing this, do not disturb the rounding of the corner of the slab. Completely remove all concrete on top of the joint filler.

Test all joints with a straightedge before the concrete has set, and make corrections if one side of the joint is higher than the other or if they are higher or lower than the adjacent slabs.

- (l) **Surface Test.** As soon as the concrete has hardened sufficiently, test the pavement surface with a 10 foot (3 m) straightedge or other specified device. Mark areas showing high spots of more than 1/8 inch (3 mm) but not exceeding 1/2 inch (12 mm) in 10 feet (3 m). Immediately grind them down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch (3 mm) when tested with a 10 foot (3 m) straightedge. Retexture the surface of ground areas to match the surface of the surrounding areas.

*NOTE: Where the departure from correct cross section exceeds 1/2 inch (12mm), the pavement shall be removed and replaced by and at the expense of the Contractor. Any area or section so removed shall be not less than 10 feet (3 m) in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 10 feet (3 m) in length shall also be removed and replaced.*

- (m) **Curing.** Immediately after the texturing operations have been completed and as soon as marring of the concrete will not occur, cover and cure the entire surface of the newly placed concrete in accordance with one of the following methods. In all cases in which curing requires the use of water, the curing shall have prior right to all water supply or supplies.

*NOTE: Failure to provide sufficient cover material, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than one-half hour between stages of curing or during the curing period.*

- (1) **Cotton or Burlap Mats.** The surface of the pavement shall be entirely covered with mats. Use mats of such length (or width) that when laid they will extend at least twice the thickness of the pavement beyond the edges of the slab. Place the mat so that the entire surface and both edges of the slab are completely covered. Prior to their being placed, thoroughly saturate the mats with water. Place and weigh down the mats to keep them in intimate contact with the surface covered, and maintain a fully wetted covering for 72 hours after the concrete has been placed unless otherwise specified.
- (2) **Impervious Membrane Method.** Spray the entire surface of the pavement uniformly with white pigmented curing compound meeting the requirements of Subsection 701.07(d)— immediately after the texturing of the surface and before the set of the concrete has taken place; or if the pavement is cured initially with jute or cotton mats, the white pigmented curing compound may be applied upon removal of the mats. Do not apply the curing compound during rainfall.

Under normal conditions, apply curing compound—by mechanical sprayers meeting the requirements of Subsection 414.03(h)—under pressure at the rate of one gallon (one liter) to not more than 200 square feet ( 5 m<sup>2</sup>). However, when the temperature on the roadway is 100°F (38°C) or above, apply the curing compound at the rate of one gallon ( one liter) to not more than 150 square feet ( 3.75 m<sup>2</sup>).

At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. Do not apply curing compound to the inside faces of joints to be sealed.

The curing compound shall be of such character that the film will harden within four hours after the application. Should the film become damaged from any cause within the required curing period, immediately repair the damaged portions with additional compound.

Upon removal of side forms, immediately protect the sides of the slabs exposed to provide a curing treatment equal to that provided for the surface.

- (3) **White Polyethylene Sheeting.** The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. Lap the units used at least 18 inches ( 450 mm). Place and weigh down the sheeting to keep it in intimate contact with the surface being covered. The sheeting as prepared for use shall have such dimensions that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, maintain the covering in place for 72 hours after the concrete has been placed.

**(4) Curing for Cold Weather.**

*NOTE: The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.*

- (n) **Removing Forms.** Remove forms carefully so as to avoid damage to the pavement. After the forms have been removed, cure the sides of the slab as outlined in one of the methods indicated above. Repair any/all honeycombed areas.
- (o) **Sealing Joints.** The joints shall be of the type shown on the Plans. All joints shall be reasonably true to the line width and depth shown on the Plans. Joints in portland cement concrete pavement shall be thoroughly clean and dry prior to placement of backer rod and/or joint sealant.
- (p) **Protection of Pavement.** Erect and maintain suitable barricades and employ watchmen as may be required to exclude traffic from newly constructed pavement for the period herein prescribed.

*NOTE: Provisions for traffic moving across the pavement shall be made at the Contractor's expense: construct suitable and substantial crossings to bridge over the concrete, which will be adequate for the traffic; protect the pavement against both public traffic and the traffic caused by employees and agents; keep all ditches and drains in such condition as to provide effective drainage; when berms of earth are placed along the shoulders, make proper provisions for the surface drainage; if any part of the pavement is damaged by traffic or other causes, occurring prior to opening to traffic, repair or replace it in a manner satisfactory to the Engineer.*

- (q) **Opening to Traffic.** Exclude traffic from the newly constructed pavement for a period of 14 days after the concrete is placed or longer if weather conditions make it advisable to extend this time. However, at the discretion of the Engineer, the pavement may be opened to traffic when specimen beams or cylinders made, cured, and tested meet the strength requirements specified in Subsection 701.01(d)
- (r) **High-Early-Strength Concrete Pavement.**
  - (1) **General Requirements.** When high-early-strength concrete pavement is specified, it shall meet the requirements of Section 701.
  - (2) **Opening to Traffic.** Traffic shall be excluded from the newly constructed pavement until the strength specified in Subsection 701.01(d) is obtained.
  - (3) **Joints.** All joints shall be constructed in accordance with Subsection 414.04(j).
- (s) **Protection Against Rain.** Until the concrete is sufficiently hardened, have available materials for the protection of the edges and surface to protect them against rain. Such protective materials shall consist of the following:

Standard metal forms or wood plank having a nominal thickness of not less than 2 inches (50 mm) and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges; and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the surface of the pavement. When rain



appears imminent, stop all paving operations and have all available personnel place forms against the sides of the pavement and cover the surface of the unhardened concrete with the protective covering.

(t) **Tolerances.**

- (1) **Surface.** The surface tolerance shall be in conformity with Section 401.04.
- (2) **Width.** The width shall be in reasonably close conformity with the dimensions shown on the Plans or established by the Engineer.
- (3) **Thickness.** After any and all grinding operations have been performed, the thickness of the pavement will be determined by the average caliper measurement of cores tested in accordance with AASHTO T 148.
  - 3.1 *Unit Identification.* For the purpose of establishing an adjusted unit price for pavement, units to be considered separately are defined as 1000 feet (300 m) of pavement in each traffic lane starting at the end, bearing the smaller station number. The last unit in each lane shall be the fractional part of 1000 feet (300 m) remaining. Units less than 250 feet (75 m) in length shall be combined with the previous unit. For entrances, crossovers, ramps, and other such areas, units to be considered separately are defined as 1000 square yards ( 1000 m<sup>2</sup>) of pavement or fraction thereof. Small, irregular areas may be included as part of another unit.
  - 3.2 *Core Locations.* One core will be taken at random by the Department in each unit. If the core is deficient in thickness by more than 0.2 inch (5 mm), two additional cores will be taken by the Department from the unit. The unit will be divided into three equal subunits. One additional core will be taken at random from each of the two subunits not represented by the original core. If the measurement of any core is less than the specified thickness by more than 1 inch (25 mm), the actual thickness of the pavement in this area will be determined by taking exploratory cores at not less than 10 feet (3 m) intervals parallel to the centerline in each direction from the affected location until in each direction a core is found which is not deficient by more than 1 inch (25 mm).
  - 3.3 *Average Thickness Determination.* When determining the average thickness for a unit, measurements which are in excess of the specified thickness by more than 0.2 inches (5 mm) will be considered as the specified thickness plus 0.2 inch (5 mm); measurements which are *less* than the specified thickness by more than 1 inch (25 mm) will not be included, and exploratory cores for deficient thickness *will not* be included.
  - 3.4 *Adjustment Payment.* Payment for the unit will be made according to the following table:

CONCRETE PAVEMENT DEFICIENCY			
AVERAGE THICKNESS DEFICIENCY (ATD) AS DETERMINED FROM CORES		PROPORTIONAL PART OF CONTRACT PRICE, PERCENT	
<u>INCHES</u>	<u>(MM)</u>	<u>INCHES</u>	<u>(MM)</u>
0 to 0.2	[0 to 5]	100	[100]
0.2 to 0.3	[5 to 7.5]	100-(200)(ATD-0.2)	[100-(8)(ATD-5)]
0.3 to 1.0	[7.5 to 25]	92-(40)(ATD)	[92-(1.6)(ATD)]
ATD = Plan Thickness-Average Thickness			

Areas found deficient in thickness by more than 1 inch ( 25 mm) shall be evaluated by the Engineer, and if the deficient areas warrant removal, they shall be removed and replaced with concrete of the thickness shown on the Plans at the expense of the Contractor. When in the judgment of the Engineer the deficient areas do not warrant removal, there will be no payment for the area retained.

Core holes shall be filled with concrete by the Contractor in a manner approved by the Engineer. The cost of filling core holes will not be a separate pay item but will be included in other bid items.

- (u) **Acceptance of Pavement.** Pavement slabs may be rejected because of unsound concrete, uncontrolled cracking, malfunctioning of the sawed joints, spalling, honeycombing, surface irregularities, insufficient thickness, or for any deficiencies commonly associated with poor quality pavements. Rejected slabs shall be removed and replaced with new pavement conforming to these requirements. The removal and replacement shall be at least one lane in width and 10 feet ( 3 m) in length. Where the linear extent of removal falls within 10 feet ( 3 m) of a transverse joint, the removal limits shall be extended to the joint.

#### 414.05. METHOD OF MEASUREMENT.

- (a) *Portland Cement Concrete Pavement*, shall be paid for by the number of square yards (square meters) of concrete pavement, of the type shown on the Plans or in the Proposal, completed and accepted, and measured complete in place. The width for measurement will be the width from outside to outside of the completed pavement, but not to exceed the width as shown on the Plans or as directed by the Engineer. The length will be the actual length measured along the riding surface on the centerline of the road, and shall exclude the length occupied by bridges, approach slabs, and all other exceptions.

*NOTE: Reinforcing steel, load transfer devices, joint fillers and joint sealers will not be measured for payment.*

- (b) *Terminal joint*, will be measured by each unit installed and shall include all steel, concrete, and other materials needed to construct the joint.
- (c) *Approach slabs*, will be measured and paid for as provided above for portland cement concrete pavement.

- (d) *Terminal joint sleeper slabs*, will be measured by the square yard (square meter) and shall include all steel, concrete and other materials needed to construct the slab.

#### 414.06. BASIS OF PAYMENT.

The accepted quantities of concrete pavement, terminal joint, and approach slabs, measured as provided above, will be paid for at the contract unit price as follows:

- (A) PORTLAND CEMENT CONCRETE PAVEMENT..... SQUARE YARD  
..... (SQ. METER)
- (A1) P.C. DOWEL-JOINTED CONCRETE PAVEMENT..... SQUARE YARD  
..... (SQ. METER)
- (B) HIGH-EARLY-STRENGTH CONCRETE PAVEMENT..... SQUAREYARD  
..... (SQ.METER)
- (B1) H.E.S. DOWEL-JOINTED CONCRETE PAVEMENT..... SQUARE YARD  
..... (SQ. METER)
- (C) APPROACH SLABS..... SQUARE YARD  
..... (SQ. METER)
- (D) PORTLAND CEMENT CONCRETE PAVEMENT  
(CONTINUOUSLY REINFORCED) ..... SQUARE YARD  
..... (SQ. METER)
- (E) HIGH-EARLY-STRENGTH CONCRETE PAVEMENT  
(CONTINUOUSLY REINFORCED)..... SQUARE YARD  
..... (SQ. METER)
- (F) TERMINAL JOINT.....EACH
- (G) TERMINAL JOINT SLEEPER SLAB..... SQUARE YARD (SQ. METER)

Such payment shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

No additional compensation will be allowed when the Contractor, at his option, uses high-early-strength portland cement in lieu of standard portland cement.

Where the average thickness of pavement is deficient in thickness by more than 0.2 inch (5 mm), but not more than 1 inch (25 mm), payment will be made at an adjusted price as specified in Subsection 414.04(t).